

# PATENT ABSTRACTS OF JAPAN

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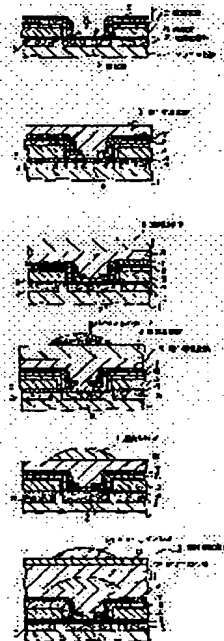
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## (54) MANUFACTURE OF SOLID-STATE IMAGE PICK-UP ELEMENT

### (57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for manufacturing a solid-state image pick-up device where an interlayer lens is formed in a desired shape to improve condensing efficiency.

SOLUTION: A method is used to manufacture a solid-state image pick-up element 15 with a light reception part 2 that is formed at the surface-layer part of a substrate 1 for photoelectric conversion, a charge transfer part 3 for transferring a charge being read from the light reception part 2, and a transfer electrode 5 being provided via an insulation film 4 at a part nearly directly above the charge transfer part on the substrate 1. In this case, a first flattening film 8 is formed by covering the transfer electrode 5, and a transparent material is formed on the first flattening film 8 by the plasma CVD method. Further, a film 9 consisting of the transparent material is subjected to patterning, thus forming a transparent material into a lens 11 in layer in a convex lens shape that projects on a part directly above the light reception part 2. Then, the lens 11 in layer is covered, a second flattening film 12 is formed, and an on-chip lens 14 is formed directly above the light reception part 2 on the second flattening film 12.



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CLAIMS

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[Claim(s)]

[Claim 1] The manufacture method of the solid state image pickup device equipped with the light sensing portion which is formed in the base surface section characterized by providing the following, and makes photo electric translation, the charge transfer section which transmits the charge read from this light sensing portion, and the transfer electrode prepared in the abbreviation right above position of the aforementioned charge transfer section on the aforementioned base through the insulator layer. The process which covers the aforementioned transfer electrode and forms the 1st flattening film. The process which forms a transparent material by the plasma CVD method on the aforementioned 1st flattening film. The process which carries out patterning of the film which consists of the aforementioned transparent material, and uses this transparent material as the lens in a layer of the shape of a convex lens which becomes convex in right above [ of the aforementioned light sensing portion ]. The process which covers the aforementioned lens in a layer and forms the 2nd flattening film, and the process which forms an on-chip lens in right above [ of the aforementioned light sensing portion on the aforementioned 2nd flattening film ].

[Claim 2] The manufacture method of a solid state image pickup device according to claim 1 characterized by providing the following. The process at which the process which carries out patterning of the film which consists of the aforementioned transparent material, and forms the lens in a layer forms a resist layer on the aforementioned transparent-material film. The process which \*\*\*\*\*s the aforementioned transparent-material film on the conditions from which the selection ratio of this resist and the aforementioned transparent material is set to about 1 by using the process which carries out patterning of this resist layer to the convex lens configuration which becomes convex, and the pattern of the acquired convex lens configuration as a mask, and forms the lens in a layer.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the manufacture method of the solid state image pickup device which raised condensing efficiency.

[0002]

[Description of the Prior Art] By 1 / small device, the improvement in sensitivity is becoming indispensable from 4"380,000 pixels especially with detailed-izing of a solid state image pickup device. In the former, an on-chip lens is prepared on a light filter, and the device of raising condensing efficiency is made by the basis of such a background.

[0003] However, although improvement in the further condensing efficiency is desired with the miniaturization of a device, and high-sensitivity-izing in recent years, the condensing effect with the on-chip lens mentioned above is approaching the limitation mostly, and development of new technology different from an on-chip lens is desired.

[0004] The technology of preparing the lens in a layer in the state of using together with an on-chip lens, as technology corresponding to such a request is proposed in part. The lens in this layer is a lens formed into an interlayer film in right above of a light sensing portion ] makes photo electric translation, makes the light which carried out incidence to the lens in this layer as well as an on-chip lens refracted by the interface by the side of the upper surface of this lens in a layer, or an inferior surface of tongue, and is led to a light sensing portion. Therefore, by using such a lens between layers together with the aforementioned on-chip lens, the light which condensed and carried out incidence with the on-chip lens can be again condensed with the lens in a layer, and, thereby, the condensing efficiency as the whole solid state image pickup device can be raised more.

[0005]

[Problem(s) to be Solved by the Invention] However, most is a concave lens, and when forming this, it is common [ the lens in a layer by which the conventional proposal is made ] to take the process of embedding high refractive-index material into the impression which formed the film which has reflow configurations, such as BPSG (boron phosphorus silicate glass), on a shading film, and was formed in right above [ transfer inter-electrode i.e., a light sensing portion, ], and using this embedded high refractive-index material as the lens in a layer. Since the deer was carried out and the configuration of the lens in a layer was decided by this process in the configuration of a reflow film, although it is difficult to acquire a desired configuration, i.e., the optimal configuration for condensing, therefore it prepared the lens in a layer, it is difficult to acquire condensing, efficiency high yet enough.

[0006] this invention was made in view of the aforementioned situation, and the place made into the purpose is to offer the manufacture method of the solid state camera it enabled it to form in the configuration which asks for the lens between layers to aim at improvement in condensing efficiency.

[0007]

[Means for Solving the Problem] The light sensing portion which is formed in the base surface section and makes photo electric translation in the solid state camera of this invention, It faces manufacturing the solid state image pickup device equipped with the charge transfer section which transmits the charge read from this light sensing portion, and the transfer electrode prepared in the abbreviation right above position of the aforementioned charge transfer section on the aforementioned base through the insulator layer. Cover the aforementioned transfer electrode, form the 1st flattening film, and, next, a transparent material is formed by the plasma CVD method on the aforementioned 1st flattening film. Subsequently, carry out patterning of the film which consists of the aforementioned transparent material, and this transparent material is used as the lens in a layer of the shape of a convex lens which becomes convex in right above [ of the aforementioned light sensing portion ]. Subsequently, it made to cover the aforementioned lens in a layer, to form the 2nd flattening film, and to form an on-chip lens in right above [ of the aforementioned light sensing portion on the 2nd flattening film of the account of back to front ] into the solution means of the aforementioned technical problem.

[0008] Since the lens in a layer is formed by carrying out patterning of the transparent-material film which formed the transparent material and was further obtained by the plasma CVD method on the 1st flattening film according to the manufacture method of this solid state camera It becomes possible to form the lens in a layer in a request configuration, without being dependent on this ground with a thing with the front face of the 1st flattening film which is a ground flat natural. Moreover, it becomes possible to become possible to choose various material from depositing and forming membranes by the plasma CVD method also about a transparent material, and to set up a refractive index arbitrarily.

[0009] In addition, in carrying out patterning of the film which consists of a transparent material, and forming the lens in a layer

Form a resist layer on a transparent-material film, and carry out patterning of this resist layer to the convex lens configuration which becomes convex continuously, and the pattern of the convex lens configuration acquired after that is used as a mask. By \*\*\*\*\*ing the aforementioned transparent-material film on the conditions from which the selection ratio of this resist and the aforementioned transparent material is set to about 1, and \*\*\*\*\*ing the aforementioned transparent-material film on the conditions from which it is desirable from which to form the lens in a layer, and a selection ratio is set to about 1 in this way It becomes easy to form in the configuration which can make the lens in a layer obtained the almost same configuration as the pattern of a resist, therefore asks for the configuration of the lens in a layer.

[0010]

[Embodiments of the Invention] Hereafter, this invention is explained in detail. Drawing 1 (a) - (c) and drawing 2 (a) - (c) is drawing for explaining the example of 1 operation gestalt of the manufacture method of the solid state image pickup device of this invention, and a sign 1 is a silicon substrate (base) in these drawings. In this example, as shown in drawing 1 (a), while forming a light sensing portion 2, the charge transfer section 3, a channel stop (illustration abbreviation), and the read-out section (illustration abbreviation) on the surface section of a silicon substrate 1 as usual, respectively, an insulator layer 4 is formed in silicon-substrate 1 front face, and the transfer electrode 5, the interlayer film insulation 6, and the shading film 7 are further formed on this insulator layer 4.

[0011] Specifically, an impurity is first poured in with an ion implantation etc. into a silicon substrate 1, this is diffused further, and the charge transfer section 3, a channel stop (illustration abbreviation), and the read-out section (illustration abbreviation) are formed, respectively. next, the oxidizing [ thermally ] method and CVD -- silicon-substrate 1 front face -- SiO<sub>2</sub> from -- the becoming insulator layer 4 is formed in addition -- this insulator layer 4 -- SiO<sub>2</sub> from -- it replaces with the becoming structure and is good also as ONO (SiO<sub>2</sub>-SiN-SiO<sub>2</sub>) structure

[0012] Next, contest polysilicon is formed by CVD, patterning of this polysilicon contest film (illustration abbreviation) is further carried out with well-known resist technology, lithography technology, and etching technology, and the transfer electrode 5 is formed. Then, the formed transfer electrode 5 is used as a mask, with an ion implantation etc., an impurity is poured in, this is diffused further and a light sensing portion 2 is formed in a self-adjustment target. In addition, about formation of this light sensing portion 2, you may form simultaneously just before or after these formation at the time of the aforementioned charge transfer section 3, a channel stop, and formation of the read-out section.

[0013] subsequently, the state where the transfer electrode 5 was covered by CVD etc. -- SiO<sub>2</sub> etc. -- from -- the becoming interlayer film insulation 6 is formed In addition, about formation of this transfer electrode 4, when transfer electrode structure is a bilayer, the aforementioned process is repeated twice, and in being three or more layers, it repeats by the number of layers.

[0014] subsequently, refractory metals, such as aluminum, an aluminium alloy or Ti, and W, -- a spatter -- a monolayer -- or double layer membrane formation is carried out And the shading film 7 and its opening 7a are formed in the film obtained by lithography technology and etching technology by [ of the right above position of opening for wiring (illustration abbreviation), or a light sensing portion 2 ] performing required patterning, such as opening, in part. In addition, about the material of this shading film 7, it is chosen according to the reflow conditions of the 1st flattening film formed next. That is, when heating at high temperature is required as reflow conditions, refractory metals, such as Ti and W, are used as a material of the shading film 7, and aluminum etc. is used when heating at high temperature is not required.

[0015] Subsequently, a BPSG (boron phosphorus silicate glass) film or HDP By performing reflow processing etc. to this further, a CVD film etc. is formed, and flattening is carried out, and as shown in drawing 1 (b), the 1st flattening film 8 is formed. In addition, in this example, the refractive index formed the 1st flattening film 8 from the BPSG film of 1.47. Therefore, since heating at high temperature is not required for reflow processing of this BPSG film, about the aforementioned shading film 7, aluminum is used as the material.

[0016] After that, if it does in this way and the 1st flattening film 8 is formed, wiring (illustration abbreviation) of a periphery will be formed, and the transparent material used as the material of the lens in a layer later mentioned on this 1st flattening film 8 is formed by the plasma CVD method, and as shown in drawing 1 (c), the transparent-material film 9 is formed. Here, about formation of the transparent-material film 9, since it carries out by the plasma CVD method generally used in a semiconductor process etc., if membranes are formed using the various material from which a refractive index differs, it can \*\*.

[0017] if it puts in another way, when raising the condensing efficiency to a light sensing portion 2 in consideration of a difference with the refractive index of the aforementioned 1st flattening film 8, or the refractive index of the 2nd flattening film mentioned later -- the [ these 1st flattening film 8 or ] -- the material of a refractive index from which the optimal refractive-index difference is acquired between 2 flattening films can be chosen For example, what is necessary is to choose a P-SiN film (plasma nitride) to set a refractive index to 1.9-2.0, and just to choose a P-SiON film (plasma oxidation nitride) to set a refractive index to 1.5-1.9. Moreover, about this transparent-material film 9, deciding the thickness according to the height of the lens in a layer to form does not have process top futility, it is advantageous and it is desirable to specifically be referred to as about 0.5-2.0 micrometers. In addition, in this example of an operation gestalt, the transparent-material film 9 was formed by forming P-SiN so that a refractive index might be set to 1.9-2.0.

[0018] Subsequently, on this transparent-material film 9, a resist is applied, a resist layer is formed, and the resist pattern 10 of the convex lens configuration which becomes convex as patterning of this is carried out further and it is shown in drawing 2 (a) is formed. In formation of this resist pattern 10, first, where plane view of the resist layer is carried out every light sensing portion 2 by etching, it divides the shape of a rectangle, and in the shape of a square. And patterning is carried out to the convex lens [ to which reflow processing of the resist layer divided in this way was carried out at the temperature of 140 degrees C - about 180 degrees C, and melting of each resist layer was once carried out ] configuration which serves as the shape of the convex spherical

surface in this resist layer by making it back-solidify, and the resist pattern 10 is obtained. In addition, although not limited especially about the kind of resist, the thing of the quality of the material which can take about 1 selection ratio between the transparent-material films 9 so that it may mention later is used more suitably.

[0019] Thus, when forming the resist pattern 10, this is made into a mask and the aforementioned transparent-material film 9 is \*\*\*\*\*ed. At this time, carrying out on the conditions from which the selection ratio of this resist pattern 10 and the transparent-material film 9 is set to about 1 preferably and specifically carries out by the pressure of 35Pa, and RF power 450W by parallel monotonous RIE about etching conditions, using SF<sub>6</sub> / O<sub>2</sub> (=40/40ccm) as reactant gas. Thus, if a selection ratio etches the transparent-material film 9 on the conditions used as about 1, as shown in drawing 2 (b), the lens 11 in a layer of the same configuration can be mostly formed with the resist pattern 10.

[0020] Subsequently, the lens 11 in a layer obtained as shown in drawing 2 (c) is covered, and the 2nd flattening film 12 is formed on the 1st flattening film 8. About this 2nd flattening film 12, although an acrylic resin (refractive-index; about 1.60), a polyimide system resin (refractive-index; about 1.80), etc. are used, in consideration of the refractive-index difference between the lenses 11 in a layer, material is especially chosen so that it may become advantageous in respect of condensing efficiency. Then, a light filter 13 is formed as usual on the 2nd flattening film 12, the on-chip lens 14 which consists of polystyrene (refractive-index; about 1.60) etc. is further formed as usual on this light filter 13, and this obtains a solid state image pickup device 15.

[0021] The lens 11 in a layer can be formed in a request configuration, without being dependent on this ground with a thing with the front face of the 1st flattening film 8 which is a ground flat natural, since it forms the transparent-material film 9 by the plasma CVD method on the 1st flattening film 8 and the lens 11 in a layer is formed by carrying out patterning of this, if it is in the manufacture method of such a solid state image pickup device 15. Moreover, various material can be chosen from depositing and forming membranes by the plasma CVD method also about a transparent material, and the flexibility and design flexibility of the material selectivity -- a refractive index can be set up arbitrarily -- can be raised.

[0022] Moreover, in case patterning of the transparent-material film 9 is carried out and the lens 11 in a layer is formed, form the resist pattern 10 of a transparent-material film 9 convex lens configuration, and this is made into a mask. Since the selection ratio of this resist and the aforementioned transparent material is \*\*\*\*\*ing the transparent-material film 9 on the conditions used as about 1 It can form in the configuration which can make the lens 11 in a layer obtained the almost same configuration as the resist pattern 10, therefore asks for the configuration of the lens 11 in a layer easily.

[0023]

[Effect of the Invention] The lens in a layer can be formed in a request configuration, without being dependent on this ground that the front face of the 1st flattening film which is a ground is flat since it is the method of forming the lens in a layer by carrying out patterning of the transparent-material film which the manufacture method of the solid state image pickup device of this invention formed the transparent material by the plasma CVD method at the 1st flattening film top, and was obtained further, as explained above. Moreover, various material can be chosen from depositing and forming membranes by the plasma CVD method also about a transparent material, and the flexibility and design flexibility of the material selectivity -- a refractive index can be set up arbitrarily -- can be raised.

[0024] Moreover, in case patterning of the transparent-material film is carried out and the lens in a layer is formed, form the resist pattern of a transparent-material film convex lens configuration, and this is made into a mask. If the selection ratio of this resist and the aforementioned transparent material \*\*\*\*\*s a transparent-material film on the conditions used as about 1, it can form in the configuration which can make the lens in a layer obtained the almost same configuration as a resist pattern, therefore asks for the configuration of the lens in a layer easily.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] (a) - (c) is an important section sectional side elevation for explaining the example of 1 operation gestalt of the manufacture method of the solid state camera of this invention in order of a process.

[Drawing 2] (a) - (c) is drawing for explaining the example of 1 operation gestalt of the manufacture method of the solid state camera of this invention, and is the important section sectional side elevation showing the process following the process shown in drawing 1 (c) in order of a process.

[Description of Notations]

1 [ -- The charge transfer section, 4 / -- An insulator layer, 5 / -- A transfer electrode, 8 / -- The 1st flattening film, 9 / -- A transparent-material film, 10 / -- A resist pattern, 11 / -- The lens in a layer, 12 / -- The 2nd flattening film, 14 / -- An on-chip lens, 15 / -- Solid state image pickup device ] -- A silicon substrate (base), 2 -- A light sensing portion, 3

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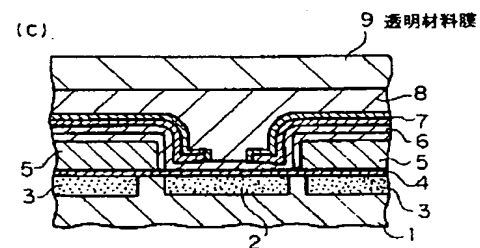
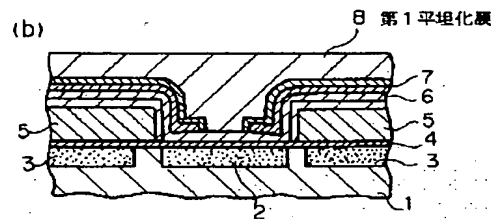
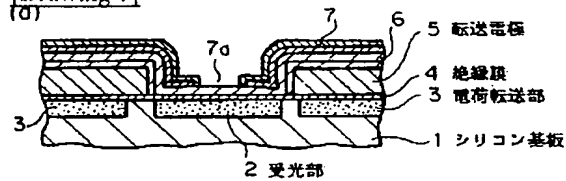
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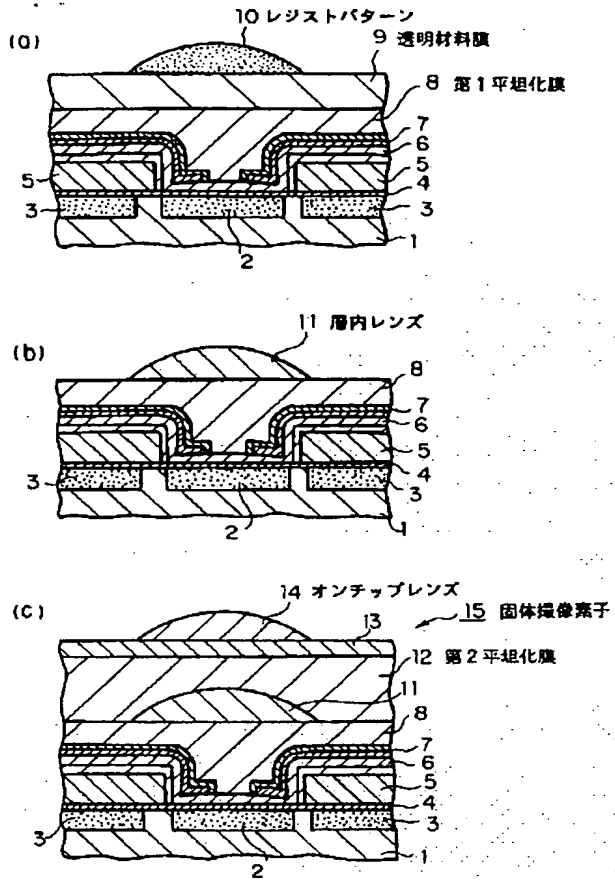
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DRAWINGS

[Drawing 1]



[Drawing 2]



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